# Software to Convert Mechanical Desktop Solid Models into Facet Files for Input to Xpatch

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## ABSTRACT

Mechanical Desktop, a solid modeling program from AutoDesk, offers engineers a powerful environment for designing ground combat vehicles. To predict the radar signatures of concept vehicles created in Mechanical Desktop, the geometry and material properties of the vehicles must be fed into Xpatch. Mechanical Desktop, however, lacks an output file format that is directly useable by Xpatch. In this paper, we discuss the problems associated with converting Mechanical Desktop files into a suitable facet format, and we present a procedure for carrying out the conversion. Moreover, we describe new software required to perform a key step in this conversion. The conversion of an example of Mechanical Desktop solid models illustrates the procedure and the new software.

## INTRODUCTION

At the U.S. Army Tank-automotive and Armaments Command (TACOM), engineers use the commercial computer aided design (CAD) program Mechanical Desktop to design ground vehicles as 3 dimensional solids. Mechanical Desktop, a product of AutoDesk, offers the vehicle designer a host of features to facilitate the design process and to produce useful output. For example, Mechanical Desktop can transform a solid model into a fully dimensioned AutoCAD drawing for use in the machine shop.

If we could use this geometric description to predict a vehicle's radar signature with Xpatch, then we could avoid the time and labor required to duplicate manually the description of the vehicle. Moreover, using the same geometry description would ensure precise configuration control. Mechanical Desktop, however, does not produce a geometry file that can be fed directly into Xpatch to predict radar signatures.

In this paper, we present a procedure to solve this problem by using a combination of commercial and custom software to convert Mechanical Desktop output files into facet files for input to Xpatch.

## CONVERSION PROCESS

Figure 1 illustrates the overall relationship of the programs involved in the conversion process. First, Mechanical Desktop creates the vehicle geometry and exports it as an IGES file. The commercial program Rhino imports the IGES file and exports it as an OBJ file. And, finally, the custom program OBJ to Facet Converter creates the facet file suitable for input to Xpatch.

Rhino, a product of Robert McNeel and Associates (www.rhino3d.com), specializes in the creation of 3 dimensional objects represented as Nonlinear Uniform Rational B Splines (NURBS). But we chose Rhino for this conversion process because it supports a wide range of input and output formats.

The OBJ to Facet Converter, the other key program in the conversion process, was written in C and Borland C++Builder to run under Windows. The program can be either command line driven or launched from a Windows graphical user interface. Computer memory sets the only limit on the size of the files that can be converted.

To handle the assignment of material codes, the user must split a vehicle into separate files for each material. Figure 2 illustrates the process of converting the separate files and recombining them into an Xpatch vehicle file.

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## DTANK: AN EXAMPLE OF THE CONVERSION PROCESS

The conversion of DTANK, an example geometry, highlights the features of the conversion process. Figure 3 shows DTANK in Mechanical Desktop, where Dr. David Hansen created the geometry for this paper. The name derives from David's Tank. The colors of DTANK represent different materials, each of which will be converted separately. From Mechanical Desktop, DTANK is exported as IGES files.

In Figure 4, Rhino displays DTANK after the IGES files have been imported. At this point, DTANK is still represented as solid objects. To export the DTANK files as OBJ files, the user can choose detailed meshing parameters, Figure 5, or can control meshing in a simpler fashion, Figure 6. The results of selecting different values for the Max. Angle meshing parameter are displayed in Figure 7.

The next step is to run OBJ to Facet Converter, Figure 8. Note that the user has the option to assign an Xpatch material number to the entire file. A dialog box, Figure 9, reports on the results of the conversion.

The separate material facet files must now be combined into a single vehicle file. The files can be combined either in one step by the Combiner program written for this paper, or the files can be combined in several steps, two files at time, by the file combining program packaged with Xpatch. The result of the combining is a single vehicle facet file with components labeled with the proper Xpatch material number, Figure 10.

The file is now ready for input to Xpatch. Figure 11 shows a synthetic aperture radar image of DTANK generated by Xpatch from the converted file.

## CONCLUSIONS

The process described here can convert geometries created in Mechanical Desktop into Xpatch compatible facet files. Future improvements might include removing internal facets.

## ACKNOWLEDGEMENT

We thank Dr. David Hansen for creating the file DTANK that we used to test the conversion process and to illustrate the process in this paper.
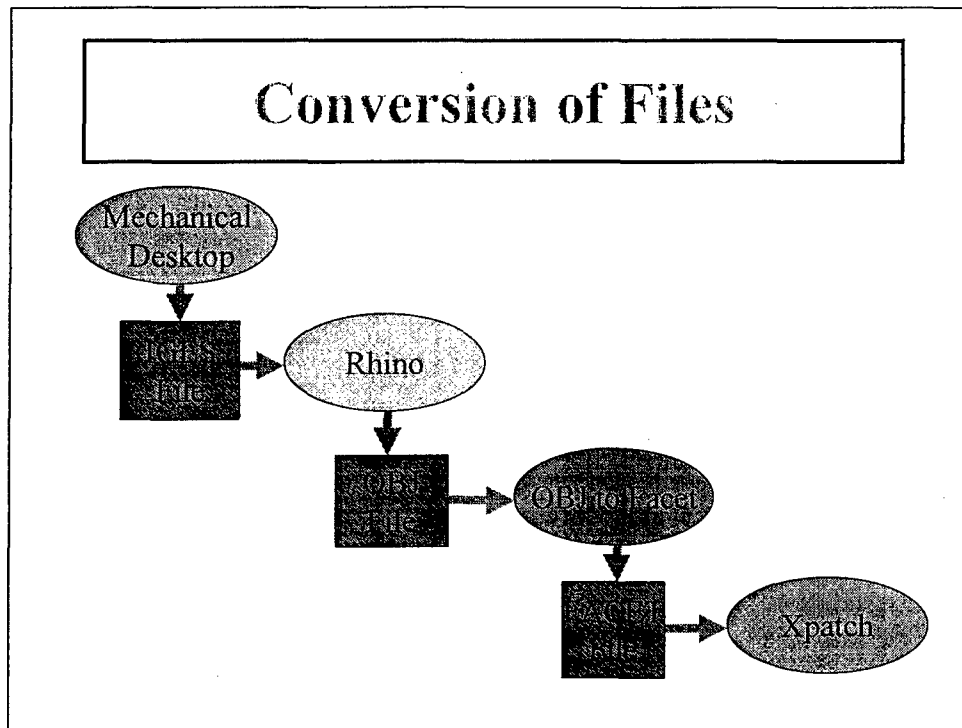
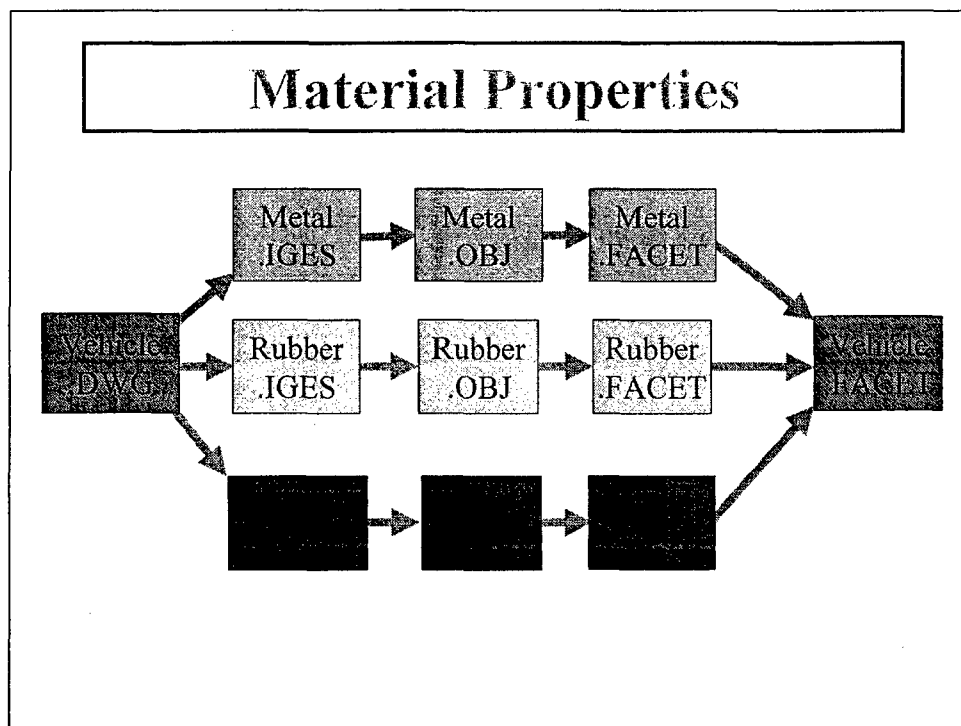Figure 1. The process of converting file from Mechanical Desktop to Xpatch.



Figure 2. Parallel conversion of components of different materials.

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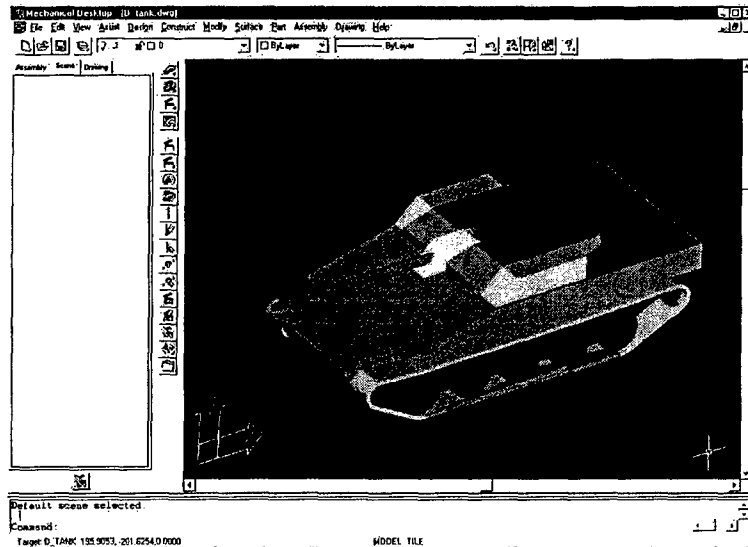Figure 3. DTANK in Mechanical Desktop.
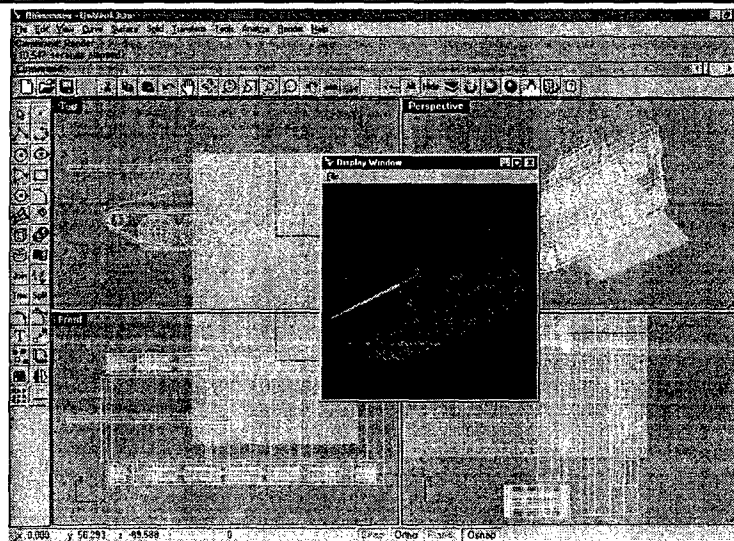


Figure 4. DTANK imported into Rhino.

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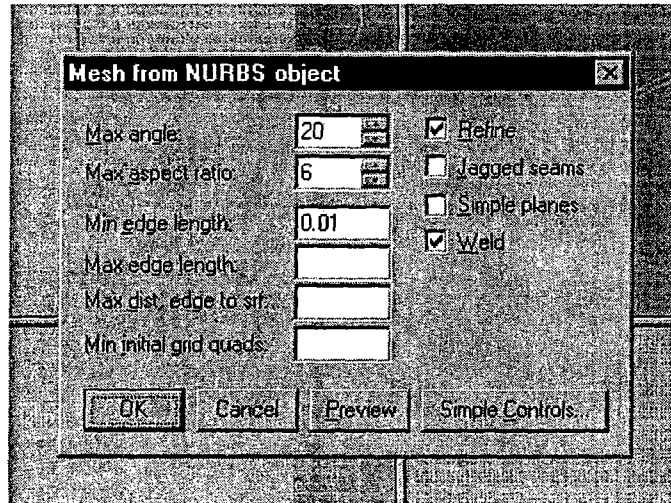
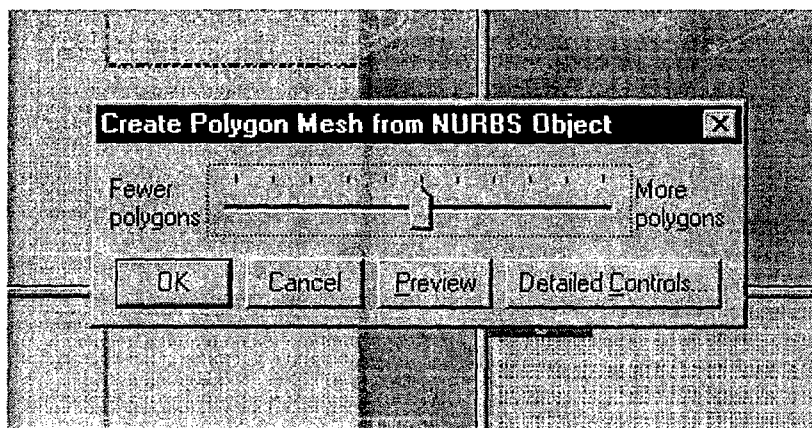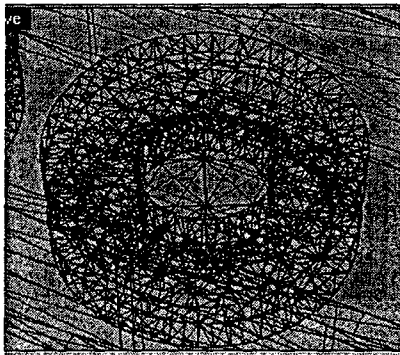Figure 5. Detailed control of meshing parameters for OBJ file.



Figure 6. Simple control of meshing parameters for OBJ file.

**Roadwheel Meshed With Max. Angle Set at 20 and 40**

20            40

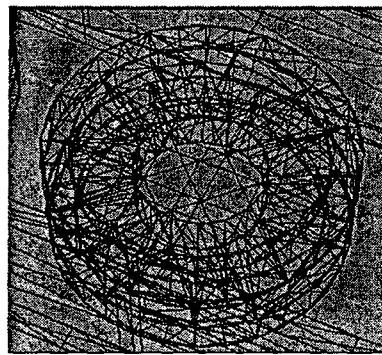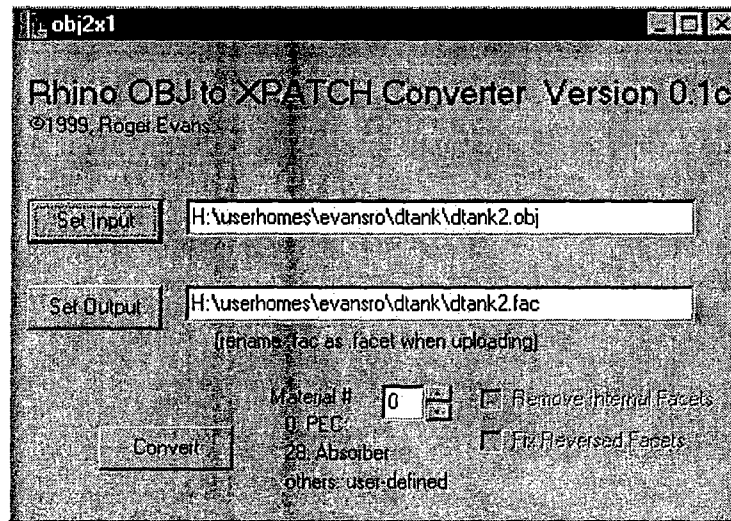Figure 7. The result of 2 values of the Max. Angle meshing parameter.

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Figure 8. Dialog box to run the OBJ to Facet Converter.
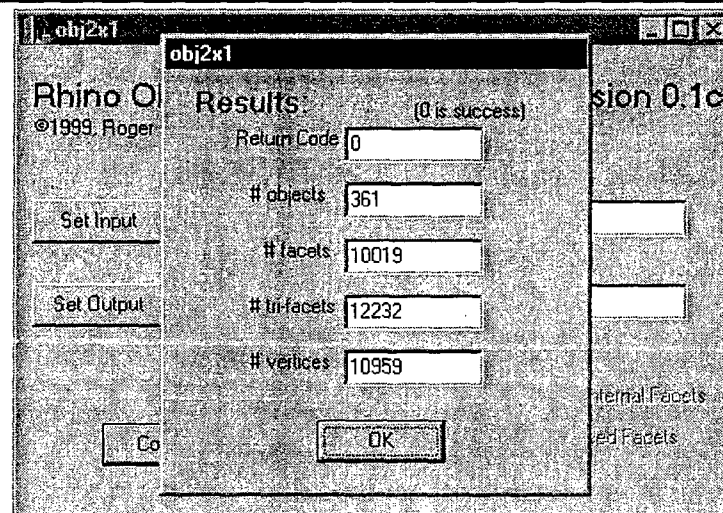


Figure 9. Report on the results of an OBJ to Facet conversion.

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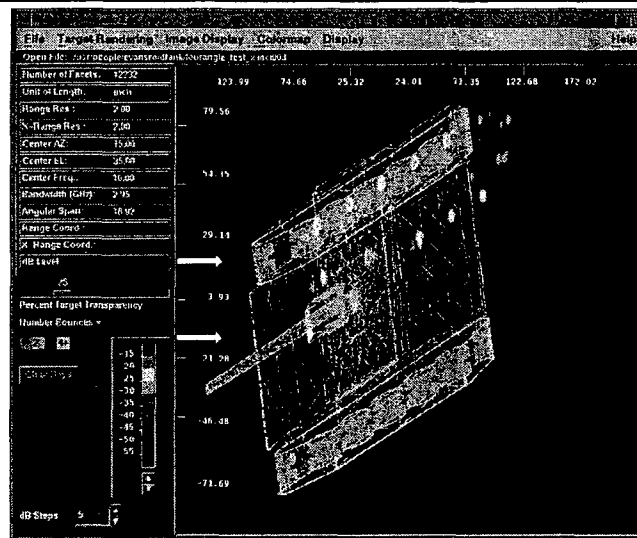Figure 10. The converted vehicle facet file displayed in Xpatch's viewer.



Figure 11. Output from Xpatch generated from the converted vehicle file.

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## Summary

- The Problem
- Mechanical Desktop and Xpatch
- File Conversion Process
- Custom Software
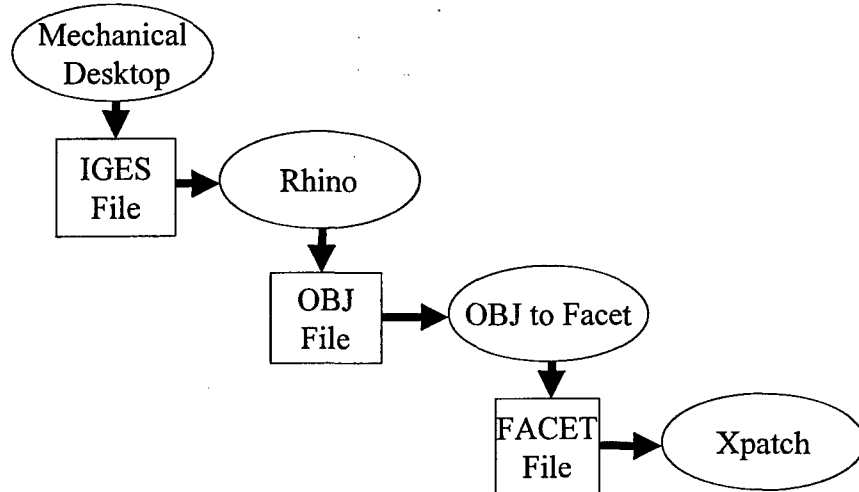- Conversion of a Tank
- Conclusions

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## The problem

•Engineers create vehicles in Mechanical Desktop

•To predict radar signatures, we must convert files into a format accepted by Xpatch

## Mechanical Desktop

• Commercial 3D CAD Program by AutoDesk

• Creation of Parts, Assemblies and Vehicles in 3D

• Works with AutoCAD to Convert 3D Geometries into Dimensioned Drawings for the Shop

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# Conversion of Files

```
  Mechanical
   Desktop
      |
      v
  ┌────────┐      ┌────────┐
  │  IGES  │─────▶│ Rhino  │
  │  File  │      └────────┘
  └────────┘           │
                       v
                  ┌────────┐      ┌──────────────┐
                  │  OBJ   │─────▶│  OBJ to Facet │
                  │  File  │      └──────────────┘
                  └────────┘            │
                                        v
                                   ┌────────┐      ┌─────────┐
                                   │ FACET  │─────▶│ Xpatch  │
                                   │  File  │      └─────────┘
                                   └────────┘
```
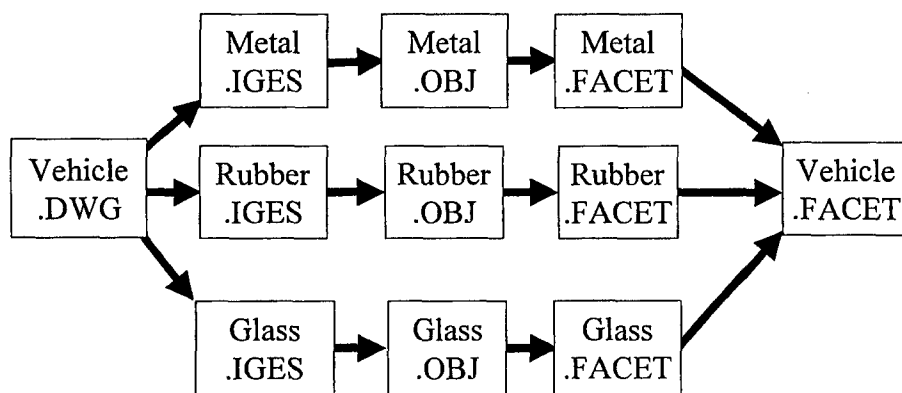
# Rhino

- Commercial Product by Robert McNeel and Associates, www.rhino3d.com
- Especially designed for easy creation of solid models using NURBs (non???)
- Supports a wide range of input and output formats
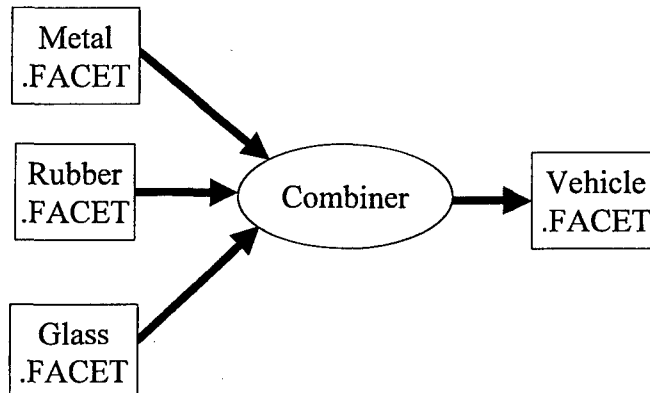- Can also be used directly to create simple geometries for input to Xpatch

## OBJ to Facet Converter

- Written in C and Borland C++Builder to run under Windows
- Both command line and GUI versions
- Can assign Xpatch material number to entire file
- Fixes minor glitches (such as?) in Rhino-created facet geometries
- File sizes limited only by memory

## Material Properties

```
                    Metal  →  Metal  →  Metal
                    .IGES     .OBJ      .FACET ↘
Vehicle   →   Rubber  →  Rubber  →  Rubber        Vehicle
.DWG          .IGES      .OBJ       .FACET    →    .FACET
          ↘
                    Glass  →  Glass  →  Glass  ↗
                    .IGES     .OBJ      .FACET
```

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# Recombining Material Files

Metal .FACET → Combiner
Rubber .FACET → Combiner
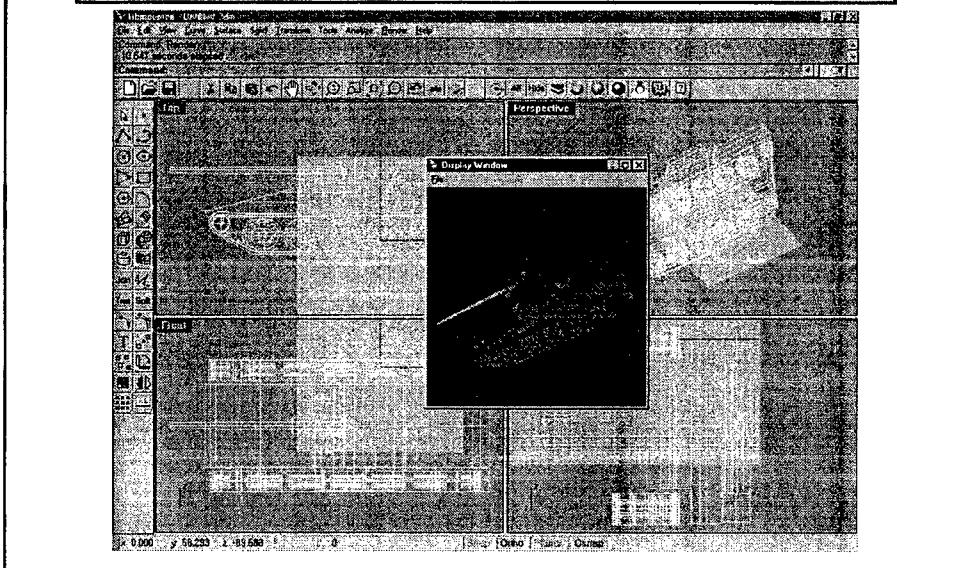Glass .FACET → Combiner
Combiner → Vehicle .FACET

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# An Example:
# The Conversion of DTANK

•Example geometry created for this paper in Mechanical Desktop by Dr. David Hansen

• DTANK = David's TANK

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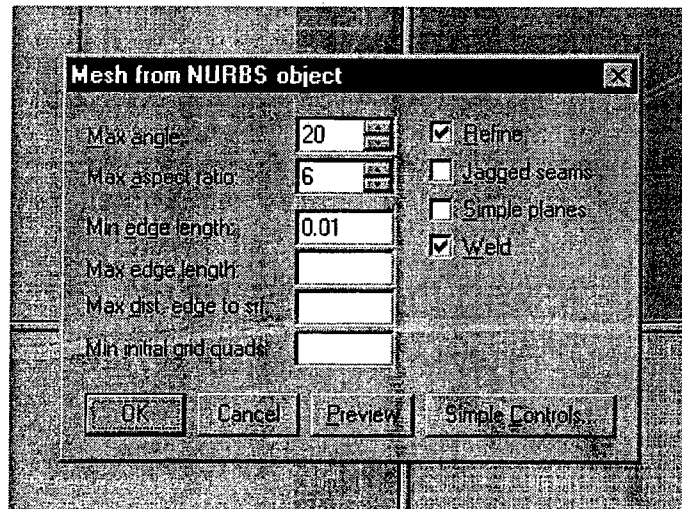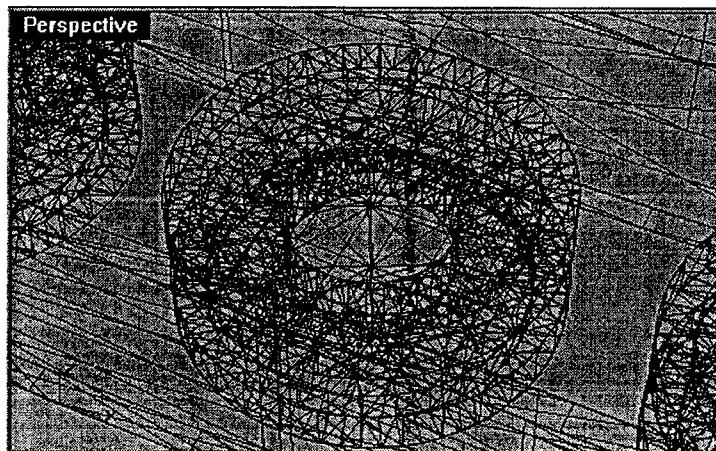
# Step 1: Export IGES File
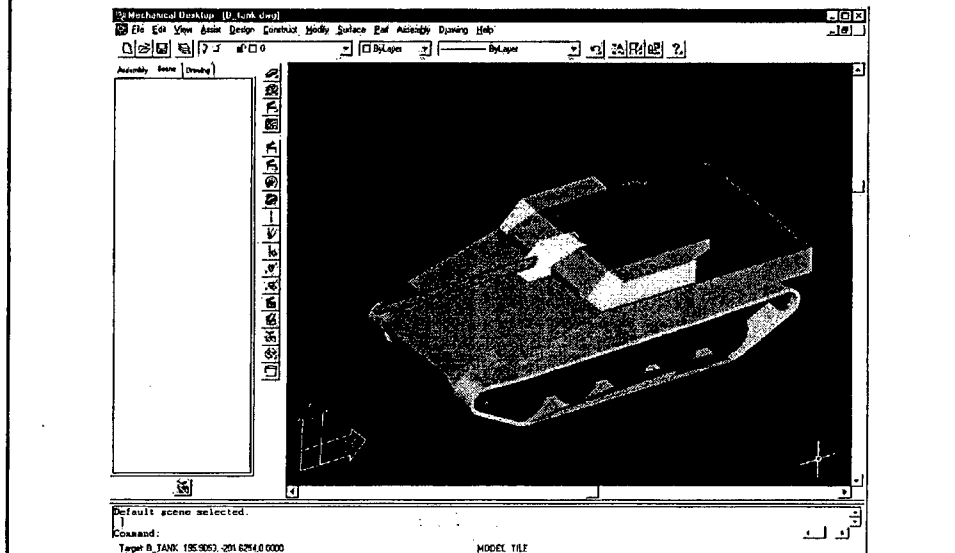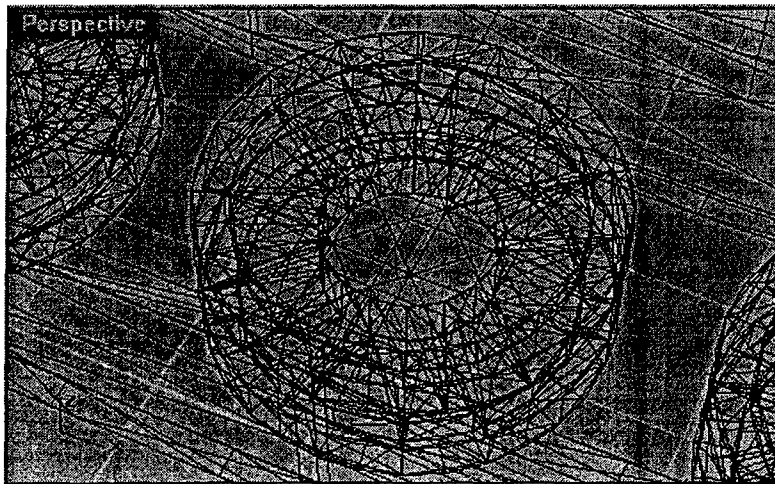


# Step 2: Import IGES File into Rhino



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# Step 3: Export File as OBJ File
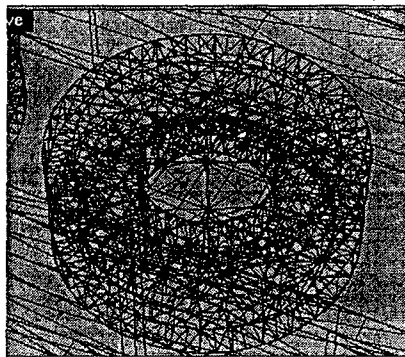


# Roadwheel meshed with Max. Angle set at 20
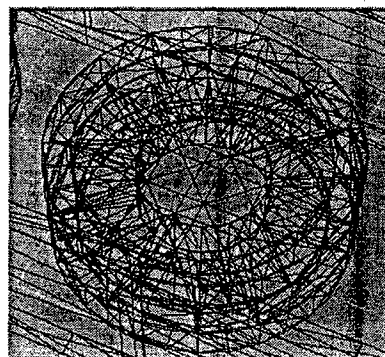


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Roadwheel meshed with
Max. Angle set at 40
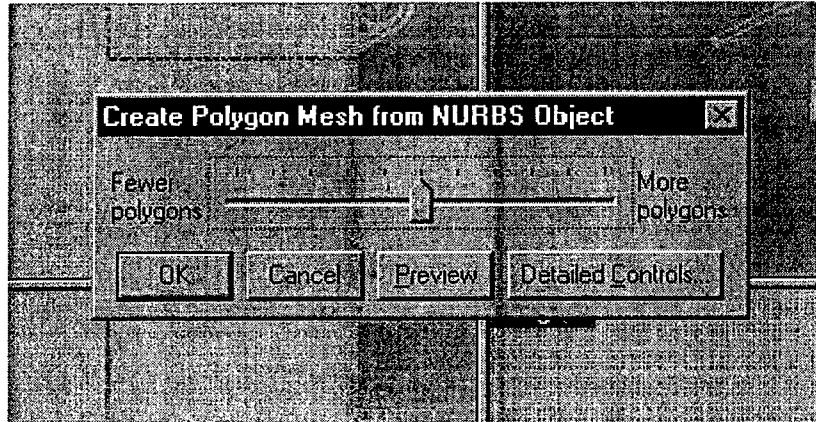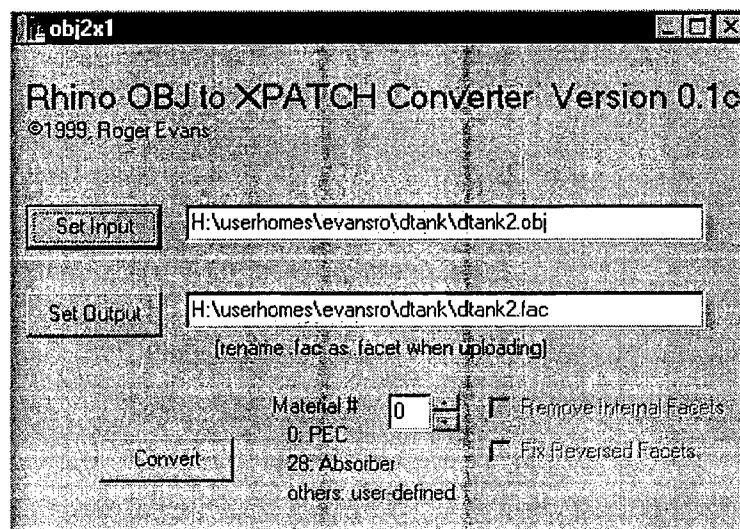


Roadwheel meshed with
Max. Angle set at 20 and 40

20       40

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# Simple Control of Meshing

**Create Polygon Mesh from NURBS Object**

Fewer polygons ———————————————— More polygons

OK   Cancel   Preview   Detailed Controls...

# Step 4: Run OBJ to facet Converter

**obj2x1**

**Rhino OBJ to XPATCH Converter  Version 0.1c**
©1999, Roger Evans

Set Input | H:\userhomes\evansro\dtank\dtank2.obj

Set Output | H:\userhomes\evansro\dtank\dtank2.fac
(rename .fac as .facet when uploading)

Material # [0]
0: PEC
Convert   28: Absorber
others: user-defined

☐ Remove Internal Facets
☐ Fix Reversed Facets
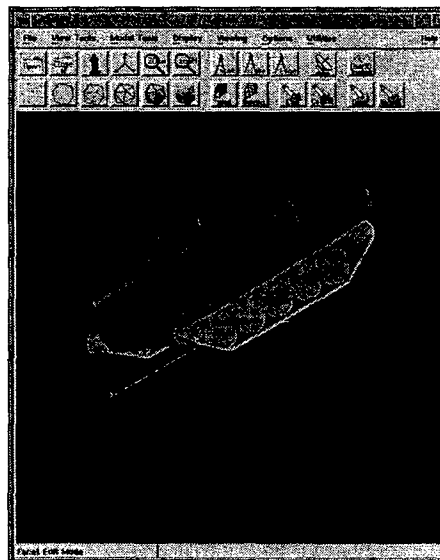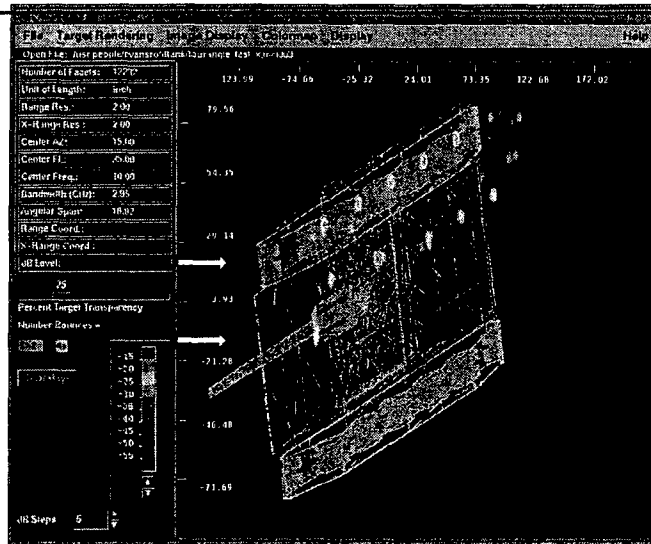
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# Results of conversion
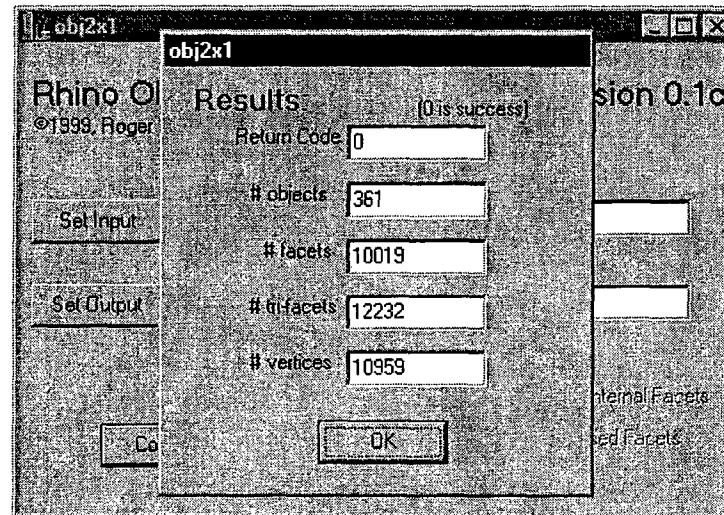


# Step 5: Combine material facet files into vehicle file

## Step 6: Run Xpatch



## Conclusions

- Our process can convert geometries created in Mechanical Desktop into Xpatch compatible facet files.

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# OPSEC REVIEW CERTIFICATION

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An abstract, summary, or copy of the information reviewed is attached for review.

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Reviewer's Determination (check one):

*This paper is unclassified and contains no military information. It deals with computer geometry conversion, is similar to open literature documents, and I see no reason to limit release. Unlimited release recommended. W Nick 12 Aug 99*

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